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EUROPEAN SCIENCE FOUNDATION STUDY CENTRE

Nonlinear Optics and Guided Waves, 1-20 August 1994

Reports from Investigation Groups

The topics on which investigation groups met during the Study Centre were:

Aug. 10
- Fibre laser issues.
- Transverse patterns and waveguiding in nonlinear optics.

Aug. 11
- 4-dimensional (space-time) structures - paraxial and non-paraxial optics.
- Characterisation of chaos in an N-dimensional N-DST equation.
- Dark solitons - are they any use?

Aug. 15
- Dynamics of coupled NLS equations.
- Future problems in optical communications.

Aug. 16
- Exact solutions for coupled NLS equations.
- All-optical switching - progress and possibilities.

Aug. 18
- Planar waveguides and spatial solitons.
- Spatial structures.

Oral Reports delivered were:

Aug. 18
- Optical Communications (Mollenauer, Kath, Smith, Gabitov).
- All-optical switching (Arnold, Hutchings, Aitchison, Tran).
- Dynamics and chaos in NLS and N-DST (Wabnitz, Akhmediev, Jones).
- Coupled NLS (Akhmediev, Aceves).
- Exact solutions for coupled NLS (Florjanczyk, Arnold, Boardman, Jones).

Aug. 19
- Dark solitons - theory and use (Kivshar, Allen).
- Spatial solitons, planar waveguides and stability (Jones, Chavez, Tran).
- Numerical issues in nonlinear optics (Perez-Garcia).
- Optical collapse in cavities (McDonald).
- Suppression of Gordon-Haus jitter without filters (McDonald, Wabnitz).
- 4-D space-time structures (McDonald, Chavez, Samson).

Written reports for distribution to all participants and sponsors (available upon request from I.C.M.S., 14 India Street, Edinburgh, EH3-6EZ, Tel: +44 131 220-1777, FAX: +44 131 220-2053, e-mail: icms@maths.ed.ac.uk) are:

Dark solitons - Various Aspects of Practical Applications	6pp
Future Problems in Optical Communications	8pp
An Alternative Scheme for a Soliton Transmission System	5pp
Exact Solutions of Coupled Nonlinear Schrödinger Equations	4pp
Ultra-Fast Switching in Semiconductor Waveguides	28pp
3-D and 4-D Structures in Paraxial and Nonparaxial Nonlinear Optics	12pp
Numerical Schemes in Nonlinear Optics	6p

Any further reports which come to hand will be notified and distributed to participants by electronic mail. Those requiring hard copy should notify I.C.M.S. at the address above.

EUROPEAN SCIENCE FOUNDATION STUDY CENTRE

Nonlinear Optics and Guided Waves, 1-20 August 1994

This Study Centre was held as a three-week workshop, with lectures, investigation sessions, library, computing facilties, lunch and refreshment facilities in the James Clerk Maxwell Building, University of Edinburgh. The majority of participants were accommodated in the nearby Suffolk Halls (Heriot Watt University) and adjacent hotels and guest houses. The Study Centre was adopted as an HCM Euroconference, so significantly helping many research students to participate throughout. The meeting formed part of the 1993-94 programme of the International Centre for Mathematical Sciences, whose premises (the birthplace of James Clerk Maxwell) were used in the final week for a reception hosted by the Edinburgh Mathematical Society. Other receptions were hosted by the Faculty of Science and Engineering, The University of Edinburgh and The City of Edinburgh District Council. Grants towards travel and subsistence costs were obtained from the International Centre for Mathematical Sciences (London Mathematical Society grant), The Royal Society, London, the International Science Foundation, the Office of Naval Research (London), the European Office of Aerospace Research and Development (U.S.A.F.), the European Research Office (U.S. Army) and from BNR (Europe) Ltd. Among the 105 participants from 20 countries, the majority of whom gave lectures or presented posters, were 32 research students and 14 post-doctoral workers.

The main aims of the Study Centre were: to advance the theory, computation and exploitation of nonlinearity in optical waveguides; to further the modelling of physical processes such as laser dynamics and active materials and to analyse the related evolution equations; to further develop techniques for large-scale computation of optical phenomena. Surveys of the various fields, providing a basis for investiation topics, were given by:

- Professor W.L. Kath (3 lectures on soliton dynamics in birefringent fibres and on long-distance propagation with phase-sensitive amplifiers).
- Dr. J.N. Elgin (3 lectures on 'The nonlinear optics of erbium-doped fibre amplifier systems').
- Dr. J. Lega (3 lectures on 'Phase and amplitude equations for lasers').
- Professor R. Indik (3 lectures on 'Numerical methods for nonlinear optics').
- Professor A.B. Aceves (3 lectures on 'Modulational instabilities in optical systems').
- Professor J.V. Moloney (2 lectures on 'Nonlinear optical interactions in large aspect ratio systems and on femtosecond timescales').
- Professor A.C. Newell (3 lectures on Maxwell-Bloch equations, pattern formation and on the inverse-scattering transform in nonlinear optics).
- Dr. L.F. Mollenauer (2 lectures on 'Ultra long distance transmission using solitons in optical fibres').

Additionally, single one-hour invited lectures were delivered by:

- Professor N.J. Doran, Solitons in optical communications.
- Dr. G.-L. Oppo, Controlling spatio-temporal chaos in nonlinear optics.
- Professor R.G. Harrison, Dynamics and chaos in nonlinear optical fibre: Theory and experiment.
- Dr. J.S. Aitchison, Spatial solitons in planar waveguides.
- Professor D.J. Kaup, Effects of inhomogeneities on the propagation of optical solitons.
- Dr. Yu.S. Kivshar, Dark solitons in nonlinear optics.

Dr. M. Brambilla, The formation and dynamics of spatio-temporal structures in nonlinear optical systems.
Professor W.J. Firth, Spontaneous optical patterns in a nonlinear cavity.
Professor H.A. Haus, Pulse propagation and pulse generation in fibres.
Dr. S. Wabnitz, Soliton interaction and switching in optical fibres.
Dr. B.A. Malomed, Soliton dynamics in nonuniform and birefringent fibres.
Dr. J.P. Gordon, Theoretical aspects of long distance soliton transmission in fibres.
Professor C.K.R.T. Jones, Dynamical systems techniques in optical wave propagation.
Professor S.W. Koch, Microscopic modelling of the nonlinear response of semiconductors.
Dr. D. Anderson, Pulse propagation determined by the NLS equation: A variational approach.
Professor J.M. Arnold, Quasi-particle approximations in the theory of optical fibre solitons.
Professor R.W. Ziolkowski, Finite-difference time-domain modelling of ultrashort optical pulse interactions with linear and nonlinear corrugated waveguides.
Dr. S. Trillo, Homoclinic instabilities in parametric three-wave mixing.
Professor A.D. Boardman, Bright/dark spatial soliton interactions.

There were, also, 21 half-hour lectures and three poster sessions, at which 32 posters were presented. No investigation sessions were timetabled until the second week, but much discussion was initiated during the first week, continuing through coffee breaks, meals, social events and during the Highland Excursion (7-9 August) in which 55 participants took part. The investigation sessions generated sufficient interest that it was rarely practical to schedule more than two simultaneously. It was clear that instigators of the investigation topics invested considerable effort in presenting topics to generate interactions between scientists from different disciplines. In some cases, significant computation was undertaken during the Study Centre, using existing code and involving the high-performance computing available in the Edinburgh Parallel Computation Centre.

Topics which generated particularly strong interactions are the subjects of the investigation group reports (see attached list). The presence simultaneously of Drs Mollenauer and Gordon (A.T.&T.) and Professor Haus (M.I.T.) provided great expertise on practical issues of long-distance optical transmission systems and on concepts and theory which might further improve system performance. Many useful ideas were generated from other groups working in the U.K., Germany, Italy, Russia and the U.S.A. (see report 'Future Problems in Optical Communications'). The presumption in favour of using existing (recently) installed fibre shows both the penalty imposed by large financial investment in technology which can rapidly be superseded and the mathematical difficulty of designing repeater systems when the attenuation is comparable with the repeater spacing. Lectures from Dr. Gabitov (Moscow/Darmstadt) and Dr. Sergeev might advance these difficult problems. Another strategy, described in 'An Alternative Scheme for a Soliton Transmission System', uses phase sensitive modulators. Theoretical, numerical and experimental work shows promise of operating long distance transmission systems at the 1.3μm window of existing (low dispersion) fibres, chosen inappropriately for the balance between nonlinearity and dispersion essential to soliton operation.

Dark solitons (i.e. localized gaps in continuous wavetrains) are a subject of much active research. Dr. Kivshar and colleagues at A.N.U., Canberra, reported many theoretical advances, while Professor Doran's group at Aston University are seeking ways of overcoming the major difficulty in generating dark solitons - the need for a πphase shift across the soliton. It seems that spatial dark solitons (self-guiding planar beams) have potential in planar switching and logic devices. There was much discussion about planar waveguides. Fabrication technology is now well advanced while, mathematically, many of the problems are closely analogous to those of fibre optics. The planar geometry generates nonlinear eigenvalue problems of significant interest to mathematical analysts (Jones, Stuart, Küpper), while the modulation theory for spatial beams generates coupled nonlinear Schrödinger (CNLS) equations. Discussion built upon the interesting amplitude-dependent switching effects described by Dr. Tran (Canberra), practical Lagrangian-variational methods outlined by Professor Boardman (Salford), and the interaction of a planar beam with a corrugated interface currently being investigated by Professor Abdullaev (Tashkent) (report to follow). Discussions on 'Exact Solutions for CNLS Equations', showed that semi-inverse, similarity and Lie-group methods are still capable of revealing new explicit solutions. While it is recognized that 'exact' solutions are extremely special, their importance in suggesting structures of lasting duration is important. A leading open question concerns the 'dissipative solitons' of Anderson, Lisak and Sergeev. Ultra-fast Switching is a major interest in Glasgow, which generated considerable interest as a complement to strictly optical topics in the Study Centre. It offers ready integration into optical networks, with topic of 3-D and 4-D Optical Structures presents profound theoretical difficulties. Current approaches are necessarily largely numerical, although justification (asymptotic) for the paraxial approximation is a significant issue. Stability of the resulting entities (light bullets, etc.) is a major concern, currently being addressed largely through numerical computation. 'Numerical Schemes in Nonlinear Optics' were largely discussed in informal sessions, following Professor Indik's three survey lectures. Some participants discussed extensively with members of the Edinburgh Parallel Computation Centre, whose director Professor Kenway was present to discuss future use of the facilities (Cray T3D), for which there is considerable scope.

Copies of notes for most of the invited speakers were freely available before the lectures, while a photocopying service was available for other notes and offprints. Visits to Professor Harrison's laboratory at Heriot-Watt University and to the optics laboratories at Edinburgh University's Physics Department were arranged. It was the general consensus that a good community spirit was fostered early, both by accommodating the majority of participants in Suffolk Halls and adjacent hotels and guest houses and through the social events. These provided excellent opportunities for the mathematicians, physicists, telecommunications and electronics engineers to exchange ideas and learn of novel viewpoints. Participants were very appreciative of the substantial scope provided for following up the many ideas raised by the lectures and posters. (Indeed, even on a walk over three of the 3,000+ ft peaks in the Monadh Liath mountains, there was considerable cross-disciplinary discussion). The Study Centre was blessed with predominantly warm and clement weather, but despite this and the attractions of the Edinburgh Festival during the third week, attendance at the working sessions was gratifyingly large and constant. The Study Centre had its problems but readily adapted to circumstances one principal speaker was on jury service and was allowed just two days in Edinburgh while delivering his three lectures, one Russian participant (mistakenly) feared his bag and passport has been stolen - so causing police to be called to the University reception, another Russian for

whom Royal Society support had been granted could not obtain a passport). The local organisers (Prof. D.F. Parker, Dr. J.G.B. Byatt-Smith and Dr. N.F. Smyth) thank all participants for their enthusiasm. They are particularly indebted to Miss Jennifer Marshall for abundant secretarial support before, during and after the Study Centre. They are also extremely grateful to the other secretaries, to Dr. Jin Liang and to many research students who helped with numerous practical arrangements.

The national and age distribution of participants was as follows:

Country	Res. Student	Young Scientists (≤35)	36 years or over.	
Australia	–	3	2	
Bangladesh	–	–	1	
Belarus	–	1	–	
Canada	–	1	–	
Denmark	1	–	–	
France	4	1	1	
Germany	3	1	4	
India	–	–	1	
Ireland	–	1	–	
Israel	–	1	2	
Italy	3	4	–	
Netherlands	–	–	1	
Poland	–	1	–	
Russia	–	–	4	
Spain	6	–	–	
Sweden	1	–	2	
Switzerland	–	–	1	
U.K.	11	11	11	
U.S.A.	2	4	10	
Uzbekistan	–	–	1	
Ghana/U.K.	1	–	–	
Greece/U.K.	1	–	–	
Mexico/U.K.	1	–	–	
Morroco/France	1	–	–	
	35	29	41	= 105

ESF Study Centre Nonlinear Optics and Guided Waves

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EUROPEAN SCIENCE FOUNDATION STUDY CENTRE

Nonlinear Optics and Guided Waves, 1-20 August 1994

Reports from Investigation Groups

The topics on which investigation groups met during the Study Centre were:

Aug. 10
- Fibre laser issues.
- Transverse patterns and waveguiding in nonlinear optics.

Aug. 11
- 4-dimensional (space-time) structures - paraxial and non-paraxial optics.
- Characterisation of chaos in an N-dimensional N-DST equation.
- Dark solitons - are they any use?

Aug. 15
- Dynamics of coupled NLS equations.
- Future problems in optical communications.

Aug. 16
- Exact solutions for coupled NLS equations.
- All-optical switching - progress and possibilities.

Aug. 18
- Planar waveguides and spatial solitons.
- Spatial structures.

Oral Reports delivered were:

Aug. 18
- Optical Communications (Mollenauer, Kath, Smith, Gabitov).
- All-optical switching (Arnold, Hutchings, Aitchison, Tran).
- Dynamics and chaos in NLS and N-DST (Wabnitz, Akhmediev, Jones).
- Coupled NLS (Akhmediev, Aceves).
- Exact solutions for coupled NLS (Florjanczyk, Arnold, Boardman, Jones).

Aug. 19
- Dark solitons - theory and use (Kivshar, Allen).
- Spatial solitons, planar waveguides and stability (Jones, Chavez, Tran).
- Numerical issues in nonlinear optics (Perez-Garcia).
- Optical collapse in cavities (McDonald).
- Suppression of Gordon-Haus jitter without filters (McDonald, Wabnitz).
- 4-D space-time structures (McDonald, Chavez, Samson).

Written reports for distribution to all participants and sponsors (available upon request from I.C.M.S., 14 India Street, Edinburgh, EH3-6EZ, Tel: +44 131 220-1777, FAX: +44 131 220-2053, e-mail: icms@maths.ed.ac.uk) are:

Dark solitons - Various Aspects of Practical Applications	6pp
Future Problems in Optical Communications	8pp
An Alternative Scheme for a Soliton Transmission System	5pp
Exact Solutions of Coupled Nonlinear Schrödinger Equations	4pp
Ultra-Fast Switching in Semiconductor Waveguides	28pp
3-D and 4-D Structures in Paraxial and Nonparaxial Nonlinear Optics	12pp
Numerical Schemes in Nonlinear Optics	6p

Any further reports which come to hand will be notified and distributed to participants by electronic mail. Those requiring hard copy should notify I.C.M.S. at the address above.

EUROPEAN SCIENCE FOUNDATION STUDY CENTRE

Nonlinear Optics and Guided Waves, 1-20 August 1994

This Study Centre was held as a three-week workshop, with lectures, investigation sessions, library, computing facilties, lunch and refreshment facilities in the James Clerk Maxwell Building, University of Edinburgh. The majority of participants were accommodated in the nearby Suffolk Halls (Heriot Watt University) and adjacent hotels and guest houses. The Study Centre was adopted as an HCM Euroconference, so significantly helping many research students to participate throughout. The meeting formed part of the 1993-94 programme of the International Centre for Mathematical Sciences, whose premises (the birthplace of James Clerk Maxwell) were used in the final week for a reception hosted by the Edinburgh Mathematical Society. Other receptions were hosted by the Faculty of Science and Engineering, The University of Edinburgh and The City of Edinburgh District Council. Grants towards travel and subsistence costs were obtained from the International Centre for Mathematical Sciences (London Mathematical Society grant), The Royal Society, London, the International Science Foundation, the Office of Naval Research (London), the European Office of Aerospace Research and Development (U.S.A.F.), the European Research Office (U.S. Army) and from BNR (Europe) Ltd. Among the 105 participants from 20 countries, the majority of whom gave lectures or presented posters, were 32 research students and 14 post-doctoral workers.

The main aims of the Study Centre were: to advance the theory, computation and exploitation of nonlinearity in optical waveguides; to further the modelling of physical processes such as laser dynamics and active materials and to analyse the related evolution equations; to further develop techniques for large-scale computation of optical phenomena. Surveys of the various fields, providing a basis for investiation topics, were given by:

- Professor W.L. Kath (3 lectures on soliton dynamics in birefringent fibres and on long-distance propagation with phase-sensitive amplifiers).
- Dr. J.N. Elgin (3 lectures on 'The nonlinear optics of erbium-doped fibre amplifier systems').
- Dr. J. Lega (3 lectures on 'Phase and amplitude equations for lasers').
- Professor R. Indik (3 lectures on 'Numerical methods for nonlinear optics').
- Professor A.B. Aceves (3 lectures on 'Modulational instabilities in optical systems').
- Professor J.V. Moloney (2 lectures on 'Nonlinear optical interactions in large aspect ratio systems and on femtosecond timescales').
- Professor A.C. Newell (3 lectures on Maxwell-Bloch equations, pattern formation and on the inverse-scattering transform in nonlinear optics).
- Dr. L.F. Mollenauer (2 lectures on 'Ultra long distance transmission using solitons in optical fibres').

Additionally, single one-hour invited lectures were delivered by:

- Professor N.J. Doran, Solitons in optical communications.
- Dr. G.-L. Oppo, Controlling spatio-temporal chaos in nonlinear optics.
- Professor R.G. Harrison, Dynamics and chaos in nonlinear optical fibre: Theory and experiment.
- Dr. J.S. Aitchison, Spatial solitons in planar waveguides.
- Professor D.J. Kaup, Effects of inhomogeneities on the propagation of optical solitons.
- Dr. Yu.S. Kivshar, Dark solitons in nonlinear optics.

Dr. M. Brambilla, The formation and dynamics of spatio-temporal structures in nonlinear optical systems.
Professor W.J. Firth, Spontaneous optical patterns in a nonlinear cavity.
Professor H.A. Haus, Pulse propagation and pulse generation in fibres.
Dr. S. Wabnitz, Soliton interaction and switching in optical fibres.
Dr. B.A. Malomed, Soliton dynamics in nonuniform and birefringent fibres.
Dr. J.P. Gordon, Theoretical aspects of long distance soliton transmission in fibres.
Professor C.K.R.T. Jones, Dynamical systems techniques in optical wave propagation.
Professor S.W. Koch, Microscopic modelling of the nonlinear response of semiconductors.
Dr. D. Anderson, Pulse propagation determined by the NLS equation: A variational approach.
Professor J.M. Arnold, Quasi-particle approximations in the theory of optical fibre solitons.
Professor R.W. Ziolkowski, Finite-difference time-domain modelling of ultrashort optical pulse interactions with linear and nonlinear corrugated waveguides.
Dr. S. Trillo, Homoclinic instabilities in parametric three-wave mixing.
Professor A.D. Boardman, Bright/dark spatial soliton interactions.

There were, also, 21 half-hour lectures and three poster sessions, at which 32 posters were presented. No investigation sessions were timetabled until the second week, but much discussion was initiated during the first week, continuing through coffee breaks, meals, social events and during the Highland Excursion (7-9 August) in which 55 participants took part. The investigation sessions generated sufficient interest that it was rarely practical to schedule more than two simultaneously. It was clear that instigators of the investigation topics invested considerable effort in presenting topics to generate interactions between scientists from different disciplines. In some cases, significant computation was undertaken during the Study Centre, using existing code and involving the high-performance computing available in the Edinburgh Parallel Computation Centre.

Topics which generated particularly strong interactions are the subjects of the investigation group reports (see attached list). The presence simultaneously of Drs Mollenauer and Gordon (A.T.&T.) and Professor Haus (M.I.T.) provided great expertise on practical issues of long-distance optical transmission systems and on concepts and theory which might further improve system performance. Many useful ideas were generated from other groups working in the U.K., Germany, Italy, Russia and the U.S.A. (see report 'Future Problems in Optical Communications'). The presumption in favour of using existing (recently) installed fibre shows both the penalty imposed by large financial investment in technology which can rapidly be superseded and the mathematical difficulty of designing repeater systems when the attenuation is comparable with the repeater spacing. Lectures from Dr. Gabitov (Moscow/Darmstadt) and Dr. Sergeev might advance these difficult problems. Another strategy, described in 'An Alternative Scheme for a Soliton Transmission System', uses phase sensitive modulators. Theoretical, numerical and experimental work shows promise of operating long distance transmission systems at the 1.3μm window of existing (low dispersion) fibres, chosen inappropriately for the balance between nonlinearity and dispersion essential to soliton operation.

Dark solitons (i.e. localized gaps in continuous wavetrains) are a subject of much active research. Dr. Kivshar and colleagues at A.N.U., Canberra, reported many theoretical advances, while Professor Doran's group at Aston University are seeking ways of overcoming the major difficulty in generating dark solitons - the need for a πphase shift across the soliton. It seems that spatial dark solitons (self-guiding planar beams) have potential in planar switching and logic devices. There was much discussion about planar waveguides. Fabrication technology is now well advanced while, mathematically, many of the problems are closely analogous to those of fibre optics. The planar geometry generates nonlinear eigenvalue problems of significant interest to mathematical analysts (Jones, Stuart, Küpper), while the modulation theory for spatial beams generates coupled nonlinear Schrödinger (CNLS) equations. Discussion built upon the interesting amplitude-dependent switching effects described by Dr. Tran (Canberra), practical Lagrangian-variational methods outlined by Professor Boardman (Salford), and the interaction of a planar beam with a corrugated interface currently being investigated by Professor Abdullaev (Tashkent) (report to follow). Discussions on 'Exact Solutions for CNLS Equations', showed that semi-inverse, similarity and Lie-group methods are still capable of revealing new explicit solutions. While it is recognized that 'exact' solutions are extremely special, their importance in suggesting structures of lasting duration is important. A leading open question concerns the 'dissipative solitons' of Anderson, Lisak and Sergeev. Ultra-fast Switching is a major interest in Glasgow, which generated considerable interest as a complement to strictly optical topics in the Study Centre. It offers ready integration into optical networks, with topic of 3-D and 4-D Optical Structures presents profound theoretical difficulties. Current approaches are necessarily largely numerical, although justification (asymptotic) for the paraxial approximation is a significant issue. Stability of the resulting entities (light bullets, etc.) is a major concern, currently being addressed largely through numerical computation. 'Numerical Schemes in Nonlinear Optics' were largely discussed in informal sessions, following Professor Indik's three survey lectures. Some participants discussed extensively with members of the Edinburgh Parallel Computation Centre, whose director Professor Kenway was present to discuss future use of the facilities (Cray T3D), for which there is considerable scope.

Copies of notes for most of the invited speakers were freely available before the lectures, while a photocopying service was available for other notes and offprints. Visits to Professor Harrison's laboratory at Heriot-Watt University and to the optics laboratories at Edinburgh University's Physics Department were arranged. It was the general consensus that a good community spirit was fostered early, both by accommodating the majority of participants in Suffolk Halls and adjacent hotels and guest houses and through the social events. These provided excellent opportunities for the mathematicians, physicists, telecommunications and electronics engineers to exchange ideas and learn of novel viewpoints. Participants were very appreciative of the substantial scope provided for following up the many ideas raised by the lectures and posters. (Indeed, even on a walk over three of the 3,000+ ft peaks in the Monadh Liath mountains, there was considerable cross-disciplinary discussion). The Study Centre was blessed with predominantly warm and clement weather, but despite this and the attractions of the Edinburgh Festival during the third week, attendance at the working sessions was gratifyingly large and constant. The Study Centre had its problems but readily adapted to circumstances one principal speaker was on jury service and was allowed just two days in Edinburgh while delivering his three lectures, one Russian participant (mistakenly) feared his bag and passport has been stolen - so causing police to be called to the University reception, another Russian for

whom Royal Society support had been granted could not obtain a passport). The local organisers (Prof. D.F. Parker, Dr. J.G.B. Byatt-Smith and Dr. N.F. Smyth) thank all participants for their enthusiasm. They are particularly indebted to Miss Jennifer Marshall for abundant secretarial support before, during and after the Study Centre. They are also extremely grateful to the other secretaries, to Dr. Jin Liang and to many research students who helped with numerous practical arrangements.

The national and age distribution of participants was as follows:

Country	Res. Student	Young Scientists (≤35)	36 years or over.	
Australia	–	3	2	
Bangladesh	–	–	1	
Belarus	–	1	–	
Canada	–	1	–	
Denmark	1	–	–	
France	4	1	1	
Germany	3	1	4	
India	–	–	1	
Ireland	–	1	–	
Israel	–	1	2	
Italy	3	4	–	
Netherlands	–	–	1	
Poland	–	1	–	
Russia	–	–	4	
Spain	6	–	–	
Sweden	1	–	2	
Switzerland	–	–	1	
U.K.	11	11	11	
U.S.A.	2	4	10	
Uzbekistan	–	–	1	
Ghana/U.K.	1	–	–	
Greece/U.K.	1	–	–	
Mexico/U.K.	1	–	–	
Morroco/France	1	–	–	
	35	29	41	= 105